ATTACHMENT 1
OU1 RD Pre-Design Work Plan

NEW CASSEL/HICKSVILLE GROUNDWATER CONTAMINATION SITE
OU1 RD PRE-DESIGN WORK PLAN

PURPOSE

This Pre-Design Investigation (PDI) Work Plan (PDIWP) describes activities to be performed by the Respondents to design the remedy for Operable Unit 1 (OU1) of the New Cassel/Hicksville Ground Water Contamination Superfund site (Site) located in Nassau County, New York (Figure 1). The remedy was selected in the OU1 Record of Decision (ROD) issued by the United States Environmental Protection Agency (EPA) on September 30, 2013 and attached as Appendix 3 to the Unilateral Administrative Order for Remedial Design (Order), Index No. CERCLA-02-2018-2015. This PDIWP has been prepared in accordance with the following:

- EPA guidance documents, including *Guidance on Oversight of Remedial Designs and Remedial Actions performed by Potentially Responsible Parties*, (OSWER directive 9355.5-01, EPA/540/g-90-001), dated April 1990.
- Section 5.2 of the New York State Department Environmental Conservation (NYSDEC) document titled, "DER-10 Technical Guidance for Site Investigation and Remediation," (DER-10) issued on May 3, 2010.
- OU1 ROD.

SITE DESCRIPTION

The Site comprises a widespread area of groundwater contamination within the Towns of North Hempstead, Hempstead, and Oyster Bay in Nassau County, New York (NY). The Site covers approximately 6.5 square miles that has been characterized by volatile organic compound (VOC) contaminated groundwater that has impacted several water supply wells, including four Town of Hempstead municipal wells (Bowling Green 1 and 2, Roosevelt Field 10, and Levittown 2A), six Hicksville water supply wells (4-2, 5-2, 5-3, 8-1, 8-3, and 9-3), and one Village of Westbury water supply well (11) shown in Figure 1. Analytical results of groundwater samples from the Site have revealed concentrations of VOCs in excess of the EPA's promulgated health-based protective maximum contaminant levels (MCLs), which are enforceable standards for various drinking water contaminants and New York State's standards.

EPA's OU1 ROD addresses a discrete portion of groundwater contamination downgradient of the New Cassel Industrial Area (NCIA), which is managed and referred to as OU1 of the Site. The Site's OU1 is located within the Towns of North Hempstead and Hempstead. OU1 is located primarily in Salisbury, an unincorporated area of the Town of Hempstead; however the portion of OU1 north of Grand Boulevard is located within the Hamlet of New Cassel in the Town of North Hempstead. A Site location map, which highlights the area encompassing OU1, is provided as Figure 1. The area comprising OU1 includes approximately 211 acres and consists of residential properties, as well as some commercial areas. Upgradient of OU1, the NCIA, which is currently being managed by the NYSDEC, encompasses approximately 170 acres. The NCIA is bounded by the Long Island Railroad to the north, Frost Street to the east, Old Country Road to the south and Grand Boulevard to the southwest.

Though currently out of service, the Town of Hempstead's Bowling Green Water District operated Wells 1 and 2 on property that is located within OU1 (labeled as Hempstead-Bowling Green Wells 1 and 2 on Figure 1). The Bowling Green Water District has been treating groundwater pumped from these two wells since 1990, when a granular activated carbon (GAC) system was installed. Five years later the treatment system was supplemented with an air stripper, and the Town of Hempstead continued to maintain

monitoring and treatment activities to address VOC contamination prior to its distribution to the drinking water system.

SITE BACKGROUND

In 2011, after the Site was included on the National Priorities List (NPL), the EPA commenced its Supplemental Remedial Investigation and Supplemental Feasibility Study which resulted in the issuance of a Supplemental Remedial Investigation (RI) Memorandum and a Supplemental Feasibility Study (FS) Memorandum, dated July 2013. The Supplemental RI Memorandum summarizes historical groundwater data, outlines response activities conducted, characterizes the Site, and provides recommendations for future investigation and response activities at the Site. The evaluation of groundwater contamination downgradient of the NCIA, designated as OU1 by the EPA, included a review of NYSDEC's September 2000 study, October 2003 remedy, and 2009 and 2011 Pre-Design Investigation Reports for the area identified by EPA as OU1 but by NYSDEC as their OU3. The Supplemental FS Memorandum updates information previously presented in the NYSDEC's study for "New Cassel Industrial Area Off-site Groundwater," (NYSDEC's OU3) dated September 2000, and introduces three additional alternatives.

SITE GEOLOGY/HYDROGEOLOGY

The principal hydrogeologic units underlying OU1 at the Site are the glacial outwash and morainal deposits known as the Upper Glacial Aquifer (UGA) and the underlying Magothy Formation and Matawan Group (Magothy). Beneath these two units are the clay member and the Lloyd Sand member of the Raritan Formation.

The UGA is estimated to be 60 to 80 feet thick and consists predominantly of coarse-grained sands and gravels. A distinct transition between the UGA and the Magothy units has not been observed in the OU1 area. The underlying Magothy Formation sediments (estimated to be approximately 600 feet thick) are characterized by sand and silty sand with discontinuous clay and silt layers. Geologic studies in the area have revealed that sediments tend to become finer in size fraction downward in the Magothy Formation, except within the basal portion where coarse-grained sands and gravels are prevalent.

Unconfined groundwater is generally found at the Site between 38 to 50 feet below ground surface (bgs). Groundwater within the UGA and Magothy aquifers flows in a south-southwest direction in the area downgradient of the NCIA. Pumping of the Bowling Green water supply wells possibly influences the groundwater flow direction above the depth of their production interval, which is approximately 470 to 580 feet below ground surface (bgs).

NATURE OF GROUNDWATER CONTAMINATION

For the purposes of this PDIWP, the term plume defines an area of groundwater contamination with concentrations of total VOCs greater than 100 micrograms per liter (µg/L). The OU1 eastern plume is comprised predominantly of tetrachloroethene (PCE) up to 16,000 µg/L with some trichloroethene (TCE) and concentrations less than 23 µg/L of 1,1,1-trichloroethane (1,1,1-TCA). The OU1 central plume consists of PCE (up to 330 µg/L), TCE (up to 990 µg/L) and 1,1,1-TCA (up to 1,400 µg/L). The OU1 western plume consists of TCE (up to 1,400 µg/L) and PCE (up to 530 µg/L) with concentrations of 1,1,1-TCA generally less than 21 µg/L, with the exception of temporary monitoring well TMW-2 that had a concentration of 88 µg/L.

Groundwater flows generally in a south-southwestern direction across the OU1 study area with localized differences which may be potentially depth-dependent and affected by nearby pumping of public supply

wells. There is a natural downward vertical gradient across the OU1 Area that is enhanced by the pumping of the Bowling Green supply wells. The contamination appears to migrate deeper as the distance along the plume axis increases away from the NCIA.

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The OU1 ROD identified Applicable or Relevant and Appropriate Requirements (ARARs), to be considered, and other guidance that were used in development of this PDIWP and will be used in the development of any future work plans for the groundwater cleanup. The list of chemical-specific, location-specific, and action-specific ARARs, to-be considered (TBCs), and other guidance can be found in Tables 8, 9, 10, respectively, in Appendix II of the OU1 ROD.

REMEDIAL ACTION OBJECTIVES

The following Remedial Action Objectives (RAOs) have been established in the OU1 ROD to address groundwater contamination for OU1 of the Site:

- Prevent or minimize current and potential future human exposure (via ingestion, dermal contact, and inhalation) to VOCs in groundwater at concentrations in excess of federal MCLs and state standards;
- Minimize the potential for further migration of groundwater with VOC contaminant concentrations greater than federal MCLs and state standards; and
- Restore the impacted aquifer to its most beneficial use as a source of drinking water by reducing contaminant levels to the federal MCLs and state standards.

The cleanup goals for the groundwater Contaminants of Concern (COCs) and their basis are presented in Table 7 of the OU1 ROD.

SELECTED REMEDY OVERVIEW

The major components of the EPA-selected remedy presented in the OU1 ROD include:

- A combination of (a) in-situ treatment of groundwater via in-well vapor stripping and (b) extraction of groundwater via pumping and ex-situ treatment of extracted groundwater prior to discharge to a publicly owned treatment works or reinjection to groundwater (to be determined during design). The purpose is to establish containment and effectuate removal of contaminant mass where concentrations of total VOCs are greater than 100 µg/L;
- In-situ chemical treatment, such as in-situ chemical oxidation, to target high concentration areas, as appropriate;
- Implementation of long-term monitoring to track and monitor changes in groundwater contamination in OU1 to ensure the remedial action objectives are attained;
- Development of a Site Management Plan to ensure proper management of the remedy post-construction. The Site Management Plan will include provisions for any operation and maintenance and long-term monitoring required for the remedy, as well as periodic certifications; and

- Institutional controls consisting of any existing local requirements that prevent installation of drinking water wells, and information devices to limit exposure to contaminated groundwater.

The areas in OU1 targeted for active remediation are shown on Figure 2.

PRE-DESIGN INVESTIGATION DIRECTIVES

This section describes the activities to be conducted during the PDI for OU1. Detailed descriptions of the tasks necessary to facilitate the development of the Remedial Design are presented herein. PDI activities will include:

- PDI Directive 1: Synoptic Water Level Gauging and Groundwater Sampling
- PDI Directive 2: VOC Concentration Groundwater Profiling and Monitor Well Installation
- PDI Directive 3: Groundwater Extraction Well Installation and/or Aquifer Testing
- PDI Directive 4: In-Well Vapor Stripping Pilot System Installation and Testing
- PDI Directive 5: In-Situ Chemical Oxidation Pilot System Installation and Testing

In accordance with Section 3.1 of the Statement of Work attached as Appendix 1 of the Order (OU1 SOW), before any field activities commence at the Site, the following plans shall be submitted to the EPA for review, modification, and approval to establish procedures to be followed in performing field, laboratory, analysis, and quality assurance work and to establish procedures, personnel responsibilities, and training necessary to protect the health and safety of all on-site personnel during the PDI:

- Relevant Respondents shall submit a Quality Assurance Project Plan (QAPP) in accordance with Section 3.1(a) and 5.7 of the OU1 SOW.
- Relevant Respondents shall submit a site-specific Health and Safety Plan (HASP) for review in accordance with Section 3.1(a) and 5.7. of the OU1 SOW.
- Relevant Respondents shall submit a Transportation and Off-site Disposal Plan for review in accordance with Section 3.1(a) and 5.7 of the OU1 SOW.
- Relevant Respondents shall submit a Quality of Life Plan for review in accordance with Section 3.1(a) and 5.7 of the OU1 SOW.

The Relevant Respondents shall submit amended QAPPs and modified HASPs, as appropriate, for each of the five directives listed for the PDI.

PDI Directive 1: Synoptic Water Level Gauging and Groundwater Sampling

Two rounds of synoptic water level gauging and groundwater sampling will be performed as part of this PDI. Details of the procedures and equipment to be used during the gauging and sampling will be contained in the QAPP. Also included in the QAPP will be the procedures and equipment to be used to contain, characterize, and properly dispose of the purge water and decontamination fluids generated during the gauging and sampling events. Groundwater level elevations will be manually measured in at least all of the permanent monitoring and extraction wells identified in Table 1, attached hereto. These wells will be sampled during two rounds of groundwater monitoring as per the OU1 SOW. These monitoring events

will be separated by a minimum of three months. The wells to be sampled during the second round include at a minimum the existing 30 monitoring wells and 2 extraction wells listed in Table 1 plus any newly installed monitoring or extraction wells pursuant to PDI Directive 2, below. Prior to each monitoring event, a well assessment survey will be performed to confirm there has been no physical changes to the wells, the measuring point elevations are still the same from previous water gauging level sampling events in OU1, and the well integrity is suitable for water level gauging and sampling.

Groundwater Level Gauging

Groundwater levels will be manually measured at each well included in the two sampling rounds. The measurements will be collected prior to sampling on a single day using an electronic water level indicator graduated to 0.01 foot. Groundwater level elevations will not be collected within 72 hours following large precipitation events if the rainfall ponds in Basin 51 as this may temporarily affect the shallow groundwater flow conditions in OU1.

Groundwater Monitoring Well Purging, Sampling, and Analysis

The purging/sampling procedures and analytical methods to be followed during the groundwater monitoring will be presented in the UFP-QAPP. Low-flow purging/sampling, with the pump set at the middle of the screened interval in wells that are not multi-ported, will be used to collect groundwater samples from the wells in accordance with the EPA Region 2 guidance document entitled *Groundwater Sampling Procedure, Low Stress (Low-Flow) Purging and Sampling* (see Appendix A). Each newly installed well will be developed at least 14 days before sampling. Sampling will progress from the least to most contaminated wells to the extent practical based on available analytical results.

- The groundwater samples will be analyzed using EPA Method 8260 for low concentrations of VOCs. The Target Compound List (TCL) for VOCs is listed in Table 2, attached hereto. Included in Table 2 is 1,4-dioxane which will be analyzed separately from the other VOCs using EPA Method 522.

- A minimum of thirty percent of the groundwater samples from the second round of sampling will be analyzed for ferrous iron (Standard Method [SM]3500-Fe D), dissolved and total metals (EPA Method 6010), total hardness (SM2340B), and alkalinity (test kit or SM2320B). The Target Analyte List (TAL) for metals will include: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, strontium, thallium, tin, vanadium, and zinc. The metals results will provide supporting data for the planning of pilot testing discussed herein.

Deliverables

- Amendments to the QAPP and/or HASP to perform PDI Directive 1 will be submitted for EPA review and approval in accordance with Section 5.7 of the OU1 SOW.

- In accordance with Section 3.1(b)(1)(i)(D) of the OU1 SOW, Respondents shall submit a PDI Directive 1 Technical Memorandum to the EPA, documenting the methods and materials that were used and including a series of tables which, at minimum, provide tabulated water levels and groundwater analytical results, along with groundwater elevation contour maps and hydraulic gradient details.

- In accordance with Section 3.1(b)(1)(ii)(E) of the OU1 SOW, Respondents shall submit a PDI Directive 1 Technical Memorandum Addendum to the EPA, documenting the methods and materials that were used and including a series of tables which, at minimum, provide tabulated water levels and groundwater analytical results, along with groundwater elevation contour maps and hydraulic gradient details.

PDI Directive 2: VOC Concentration Groundwater Profiling and Monitoring Well Installation

Additional data collection is warranted to support the remedial design along certain transects (T1 through T9 on Figure 3) through the OU1 plumes. This will be accomplished using a combination of depth-discrete VOC concentration profiling in temporary boreholes with installation and sampling of additional permanent groundwater monitoring wells. Data obtained from the sampling of the temporary boreholes and groundwater monitoring wells will be used by the Respondents to obtain data necessary for the design to estimate the horizontal and vertical extents as well as to extrapolate the centerline positions of the OU1 plumes based on a 100 µg/L concentration of total VOCs, consistent with the OU1 ROD.

VOC Concentration Profiling

Eleven groundwater profile borings ranging in depth to approximately 460 feet (Table 3) will be drilled and sampled within OU1 at the locations shown on Figure 3. All drilling and sampling activities will be performed in one phase using methods that provide continuous samples in a wide range of unconsolidated deposits. Groundwater profile samples from all designated borings will be collected at 20-foot intervals from the water table (estimated at approximately 40 feet) through the depth ranges listed in Table 3. The groundwater samples will be collected by lowering and raising non-dedicated, decontaminated sampling equipment inside the drill casing. Laboratory analysis of the groundwater samples for TCL VOCs (provided in Table 2) shall be performed using a turnaround time to provide uninterrupted groundwater profile sampling should a variance be necessary in the depths provided in Table 3. Relevant Respondents shall provide the laboratory analytical results (i.e., fixed or mobile laboratory) by telephone and electronic mail to the EPA in a timeframe that allows EPA to make a final determination without delaying the groundwater profiling as to the appropriate sample depth if a variance from Table 3 is indicated. Groundwater profile sampling at depths requiring a variance shall not be conducted until approved by the EPA through electronic mail and by telephone.

Groundwater Monitoring Well Installation

As defined herein, a shallow well depth shall mean less than 175 feet, an intermediate well depth shall mean between 175 and 250 feet and a deep well depth shall mean greater than 250 feet. After the groundwater sampling is completed at the 11 profiling boreholes (i.e., PDI-20/MW-20, PDI-22/MW-22, PDI-23/MW-23, PDI-27/MW-27, PDI-28/MW-28, PDI-30/MW-30, PDI-32/MW-32, PDI-35/MW-35, PDI-38/MW-38, PDI-41/MW-41, and PDI-44/MW-44), as discussed above, and drilling is completed at the other eight boreholes (i.e., MW-26, MW-29, MW-34, MW-36, MW-40, MW-42, MW-43, and MW-45) identified in Table 3 and/or Figure 3, they will be converted into groundwater monitoring wells. Eight groundwater monitoring well locations listed in Table 3 and shown on Figure 3 may be installed to obtain design parameters dependent on the results of VOC concentration profiling from nearby locations. A total of 37 monitoring wells will be installed and screened as listed in Table 3, unless TCL VOC results from the groundwater profiling indicates that revised intervals are required, as determined by EPA. Well screens requiring a depth variance will not be installed until their construction is approved by the EPA. The plume(s) will be screened at depths above, below, and within the core of the plume. Wells located along

the west and/or east of the centerline of the plume(s) will be screened at a depth corresponding to the core of the plume. Therefore, the centerline profile borings should be completed prior to installation of the monitoring wells to the west and/or east of the centerline. The objective of the groundwater monitoring well installation is to obtain design data that will be used by the Relevant Respondents for the in-well vapor stripping and groundwater extraction wells.

The wells shall be drilled using a method that is capable of advancing appropriately sized diameter boreholes through a wide range of unconsolidated deposits to an approximate depth of at least 460 feet or deeper depending on the profiling results. Multiple wells may be nested or multi-ported in a single borehole or the wells may be clustered in separate boreholes at the selected locations. At a minimum, the deepest borehole at each location will be continuously cored and the cores will be logged for lithology.

Each monitoring well will be designed and constructed with a minimum two-inch diameter to provide representative groundwater samples and groundwater data. American Society for Testing and Materials (ASTM) D5092-04(2010)e1 entitled *Standard Practice for Design and Installation of Groundwater Monitoring Wells* shall be used as a guidance in the monitoring well design and installation. A 10-foot screen length shall be installed for each nested or clustered well, but a longer screen length identified by the Relevant Respondents in the field based on hydrogeologic conditions will be considered for EPA approval following notification of the Remedial Program Manager by telephone and electronic mail. Each well will be fitted with a watertight PVC (J-plug) lockable cap. The cap will be secured to the casing with a non-corrosive padlock. All well locks will be keyed alike, and a copy of the key shall be provided to EPA within seven days of completion. The monitoring wells will be completed either above ground or flush to the ground. For flush-mount well completions, a traffic-rated locking or bolted vault will be placed over the well casing and cemented in place. Above ground completions will use a steel protective casing (at least 5 feet in length) extending about 2.5 feet above ground and set in concrete. The bottom of the steel casing will extend below the frost line. The protective casing inside diameter will be at least four inches greater than the nominal diameter of the well riser. The annulus between the protective casing and the well riser will be filled with cement to a minimum of 0.5 feet above ground surface as part of the overall grouting. A locking hinged cover or slip cap will be fitted at the top of the protective casing to keep precipitation out of the casing. A 4-inch thick and 2-foot square concrete apron will be installed around each cover/vault and if permissible will be tapered outward from the cover/vault to prevent or minimize surface water from entering beneath the protective steel well cover. Protective bollards will be installed around the well outside the concrete pad for protection from vehicular activity, as appropriate. Well Completion Reports (WCRs) for the newly installed monitoring wells will be submitted on behalf of the Relevant Respondents to the NYSDEC Regional Headquarters office in Stony Brook, NY where well identification numbers will be assigned to the wells. Copies of the final WCRs will also be submitted to the EPA in the PDI Directive 2 Technical Memorandum.

The monitoring wells will be developed no sooner than 48 hours after final grouting of the well. Development will be performed by pumping using a submersible pump until pH, temperature, electrical conductivity, and turbidity have stabilized for three consecutive readings at equal time intervals. The readings are considered stable when they are within the following guidelines:

- ±0.1 units for pH.
- ±10% for turbidity values greater than 50 nephelometric turbidity units (NTUs) or three consecutive readings below 10 NTUs.
- ±3% for electrical conductivity and temperature.

The horizontal and vertical coordinates of the adjacent ground surface, vault rim or top of outer protective casing, and a reference point at the top of the newly installed inner well casings will be determined by a land surveyor licensed in NY State using equipment and methods that are discussed in the QAPP.

Deliverables

- Amendments to the QAPP and/or HASP to perform PDI Directive 2 shall be submitted for EPA review and approval, pursuant to Section 5.7 of the OU1 SOW.
- Relevant Respondents shall submit a PDI Directive 2 Technical Memorandum to the EPA for review and approval in accordance with Section 3.1(b)(2)(iv) of the OU1 SOW, documenting the methods and materials that were used and including well construction logs, a series of tables which at minimum provide tabulated groundwater profiling analytical results along with a boring and well location map.

PDI Directive 3: Groundwater Extraction Well Installation and/or Aquifer Testing and Groundwater Extraction System Effluent Evaluation

With respect to PDI Directive 3, as presented below, three options are available to the Relevant Respondents for determining the groundwater extraction well installation and testing data to be used in the remedial design. At least one option must be selected. 3.

Aquifer Test Option 1: Use Previously Reported Test Results from Existing OU1 Extraction Wells

Relevant Respondents will utilize available results obtained from the installation and testing of intermediate groundwater extraction well EX-1 (step and constant-rate testing) and deep groundwater extraction well EX-2 (step testing) conducted in 2011 by Henningson, Durham & Richardson Architecture and Engineering, P.C. (HDR). Extraction well EX-1 was installed at a depth of 205 feet bgs along the axis of the eastern plume. In the western plume, extraction well EX-2 was installed at a depth of 285 feet bgs, Both wells were step tested and the specific capacity results averaged 5.4 gallons per minute per foot of drawdown (gpm/ft) at EX-1 and 9 gpm/ft at EX-2 (HDR, 2011). Based on the application of a leaky solution to the 72-hour pump test data, HDR (2011) reported horizontal hydraulic conductivities of 52 to 155 feet/day, vertical hydraulic conductivities of 1.4 to 3.1 feet/day, anisotropies of 17 to 100 (dimensionless), and specific storage values of 0.003 to 0.008 (dimensionless) for the Magothy aquifer at EX-1. The Relevant Respondents shall submit a Technical Memorandum to the EPA with the presentation of the data, a summary of the parameter values they are proposing to use for the final remedial design, and an explanation as to why those values are applicable to OU1.

Aquifer Test Option 2: Conduct a Literature Review and Use Published Test Results for the Magothy Aquifer

Relevant Respondents may conduct a literature search of well discharge rates and aquifer parameter values (minimum, maximum, and average) for the Magothy aquifer in central Nassau County, NY. The Relevant Respondents shall submit a Technical Memorandum to the EPA with a presentation of the data, a summary of the parameter values they are proposing to use for the final remedial design, and an explanation as to why those values are applicable to OU1.

Aquifer Test Option 3: Use Results from the Testing of Newly Installed or Previously Untested OU1 Extraction Wells

Relevant Respondents will utilize data generated during the installation and testing of a deep groundwater extraction well (step and constant rate tests) or the testing of an existing deep extraction well EX-2 (constant rate test). The preferred location for a new deep extraction well is near the southern boundary of the eastern plume (where total VOC concentrations are greater than 1,000 µg/L but less than 10,000 µg/L) in OU1. However, the Relevant Respondents may submit an amendment to the QAPP for EPA approval of their selection of an alternative depth and location for a new groundwater extraction well after consideration of the groundwater sampling results obtained for existing and new monitoring wells following completion of Directive 1.

The extraction well will be drilled using a method that is capable of advancing, at minimum, a 10-inch diameter borehole through a wide range of unconsolidated deposits to the target depth. The extraction well will be designed by an experienced geologist using grain size analysis for selection of the screen slot size and filter pack. Also, well construction details (diameter, casing and screen types, annular materials and wellhead completion) will be provided in the QAPP or an amendment to the QAPP. Wellhead completion will be performed using traffic-rated flush-mounted vaults in residential areas with vehicular and pedestrian traffic, unless an alternative completion is more appropriate in a particular instance and such method is approved by the EPA. Relevant Respondents shall notify the Remedial Project Manager by telephone and electronic mail for EPA review and approval of an alternative completion. Alternative wellhead completions shall not be installed unless approved by the EPA.

At a minimum, the new extraction well will be developed consistent with the protocol and procedures required for the monitor wells under PDI Directive 2. The horizontal and vertical coordinates of the adjacent ground surface, vault rim, and a reference point at the top of the newly installed inner well casing will be determined by a NY licensed land surveyor using equipment and methods provided in the QAPP.

The newly installed extraction well will be step tested. Either the newly installed extraction well or existing extraction well EX-2 will also be constant rate tested for a minimum of 72 hours. Pre-test and post-test water levels in the pumping and observation wells shall be monitored for at least one week before and after the constant rate test using pressure transducers with onboard dataloggers. A sufficient number of observation wells shall be monitored during the constant rate test that will adequately characterize the effects of the pumping test and any interference from the pumping of nearby supply wells. New observation wells shall be installed if existing monitoring wells are unsuitable for that purpose. Both pumping and recovery data shall be collected during the constant rate test to obtain estimates of the aquifer parameters. The data shall be reported as raw measurements and appropriately corrected measurements to remove all groundwater level influences identified during the testing (i.e., rainfall, seasonal trends, barometric changes, supply well pumping, etc.).

Groundwater Extraction System Effluent Discharge Evaluation

Options for managing the treated effluent from the groundwater extraction system will be evaluated during the remedial design. Data for that evaluation will be collected during this PDI. Therefore, one or more of the following discharge options shall be assessed using potable water (if Groundwater Extraction System Effluent Discharge Evaluation Options 1 or 2 are selected) or treated groundwater (if Groundwater Extraction System Effluent Discharge Evaluation Options 3 or 4 are selected):

- Effluent Discharge Evaluation Option 1: Discharge to infiltration wells in Nassau County Department of Public Works (NCDPW) Basin 51. Results of previous or new infiltration tests will

be used to calculate the capacity of the recharge basin for accepting the extraction system effluent. Relevant Respondents shall coordinate with NCDPW as they may be able to provide infiltration test results for Basin 51. If previous test data does not exist, a minimum of four percolation tests will be performed in the recharge basin using the sealed double ring infiltrometer (SDRI) method in accordance with ASTM D3385. The test locations will be evenly spaced around the basin. Shallow test pits will likely be required to facilitate the infiltration testing. In addition, a minimum of four soil borings will be drilled to an approximate depth of 35 feet with samples collected for grain-size analysis at a depth of 5 feet and then at 5-foot intervals to the total depth. Run-off from a representative 25-year rainfall event will also be calculated to verify the available capacity for treated groundwater discharge. The Relevant Respondents may also propose in the QAPP or in an amendment to the QAPP for EPA review and approval, an alternative approach for characterizing the infiltration capacity of Basin 51. Relevant Respondents shall submit for EPA review and approval an Effluent Discharge Evaluation Option 1 Technical Memorandum documenting any previous or new infiltration test results for Basin 51.

- Effluent Discharge Evaluation Option 2: Discharge to a gallery of shallow (unsaturated Upper Glacial aquifer) or deep (saturated Magothy aquifer) infiltration wells located either upgradient, crossgradient, or downgradient of the OU1 plumes. If discharge to Basin 51 is not feasible, then the Relevant Respondents shall propose in a QAPP amendment for EPA review and approval an alternative location, construction, and depth for testing of the infiltration wells. The re-injection of treated effluent shall not alter the orientation of the VOC plumes in OU1 nor adversely impact the nearby public supply wells or the aquifer. The design parameters required for the remedial design include the construction, depth, location, and number of infiltration wells required to inject the anticipated volume of treated groundwater. This will be evaluated by the Relevant Respondents during the remedial design using results obtained from field testing (i.e., infiltrometer, falling head, or stepped injection rate tests) or numerical modeling. An Underground Injection Control (UIC) well inventory form (7620-18) will be submitted to the UIC branch of EPA Region 2 for a determination on permitting requirements prior to commencing any injections. Relevant respondents shall submit for EPA review and approval an Effluent Discharge Evaluation Option 2 Technical Memorandum documenting any new results for effluent discharge outside Basin 51.

- Effluent Discharge Evaluation Option 3: Discharge of treated groundwater through a connection to the Nassau County sanitary sewer system. Under this option, Relevant Respondents will evaluate the feasibility of discharging to a publicly owned treatment works. At minimum, the Relevant Respondents will submit for EPA review and approval an Effluent Discharge Evaluation Option 3 Technical Memorandum which identifies and addresses various Federal, state, and local stakeholder considerations, identifies an accessible and available sanitary sewer, and ascertains the permits, rules, regulations, and specifications applicable for discharging to that sewer. This will include but not be limited to the permit application process and fee, discharge capacity and limits, and usage fee.

- Effluent Discharge Evaluation Option 4: Relevant Respondents may elect to propose other alternative discharge approaches to the EPA for review and approval in an Effluent Discharge Evaluation Option 4 Technical Memorandum.

Deliverables

Amendments to the QAPP and/or HASP to perform PDI Directive 3 shall be submitted for EPA review and approval of any such QAPP amendments, and EPA review of any such HASP amendments, pursuant to Section 5.7 of the OU1 SOW.

Aquifer Testing

Pursuant to Section 3.1(b)(3)(i) of the OU1 SOW, Relevant Respondents will notify EPA as to which aquifer testing option the Relevant Respondents elect to use. Pursuant to Section 3.1(b)(3)(ii) of the OU1 SOW, Relevant Respondents will submit one or more of the following Technical Memorandums to EPA for review and approval to meet the aquifer testing requirement as described above in PDI Directive 3:

- If Relevant Respondents elect to use Aquifer Test Option 1: Use Previously Reported Test Results from Existing OU1 Extraction Wells to meet the aquifer testing requirement under PDI Directive 3, then an Aquifer Test Option 1 Technical Memorandum, shall be submitted to EPA for review and approval. The Aquifer Test Option 1 Technical Memorandum will, at a minimum, present the data, a summary of the proposed parameter values that will be used for the remedial design, and an explanation as to why those values are applicable and acceptable.

- If Relevant Respondents elect to use Aquifer Test Option 2: Conduct a Literature Review and Use Published Test Results for the Magothy Aquifer, to meet the aquifer testing requirement under PDI Directive 3, then an Aquifer Test Option 2 Technical Memorandum shall be submitted to EPA for review and approval. The Aquifer Test Option 2 Technical Memorandum will, at minimum, provide the available and tabulated aquifer testing data, a summary of the parameter values the Relevant Respondents are proposing to use for the remedial design, and an explanation as to why those values are applicable and acceptable.
- If Relevant Respondents elect to use Aquifer Test Option 3: Use Results from the Testing of Newly Installed or Previously Untested OU1 Extraction Wells to meet the aquifer testing requirement under PDI Directive 3, then an Aquifer Test Option 3 Technical Memorandum will be submitted to EPA for review and approval. The Aquifer Test Option 3 Technical Memorandum will, at a minimum, document the methods and materials that were used and including construction logs for the extraction and observation wells, well location map, tabulated raw and corrected test data, graphs of corrected test data, aquifer parameter values derived from the testing, a summary of the proposed parameter values that will be used for the remedial design, and an explanation as to why those values are applicable and acceptable.

Effluent Discharge Evaluation

Pursuant to Section 3.1(b)(3)(i) of the OU1 SOW, Relevant Respondents will notify EPA as to which effluent discharge evaluation option the Relevant Respondents intend to evaluate. Pursuant to Section 3.1(b)(3)(ii) of the OU1 SOW, Relevant Respondents will submit one or more of the following Technical Memorandums to EPA for review and approval to meet the groundwater extraction system effluent discharge requirement as described above in PDI Directive 3:

- If the Relevant Respondents evaluate Effluent Discharge Evaluation Option 1, a Technical Memorandum shall be submitted to EPA for review and approval pursuant to Section VI of the OU1 SOW. The Effluent Discharge Evaluation Option 1 Technical Memorandum will, at a minimum, provide the methods and materials, a test borehole location map, tabulated and graphical representation of analytical and infiltration test results, and conclusions.

- If the Relevant Respondents evaluate Effluent Discharge Evaluation Option 2, a Technical Memorandum shall be submitted to EPA for review and approval pursuant to Section VI of the

OU1 SOW. The Effluent Discharge Evaluation Option 2 Technical Memorandum will, at a minimum, provide methods and materials, alternative test borehole location map, analytical and infiltration test results, and conclusions.

- If the Relevant Respondents evaluate Effluent Discharge Evaluation Option 3, a Technical Memorandum shall be submitted to EPA for review and approval pursuant to Section VI of the OU1 SOW. The Effluent Discharge Evaluation Option 3 Technical Memorandum will, at a minimum, document the findings and feasibility of discharging effluent to the Nassau County sanitary sewer system.

- If the Relevant Respondents elect to use Effluent Discharge Evaluation Option 4, then a Technical Memorandum shall be submitted to EPA for review and approval pursuant to Section VI of the OU1 SOW. The Effluent Discharge Evaluation Option 4 Technical Memorandum will present the methods and materials, findings and conclusions.

Relevant Respondents shall submit a PDI Directive 3 Technical Memorandum to EPA for review and approval in accordance with Section 3.1(b)(3)(ii) of the OU1 SOW, documenting, under one cover, the methods, materials, and findings of the options they selected for the aquifer testing and effluent discharge evaluation and the applicability and acceptability of those findings for the remedial design.

PDI Directive 4: In-Well Vapor Stripping Pilot System Installation and Testing

In-well vapor stripping (IWVS) typically relies on the formation of a groundwater circulation cell in the aquifer and the simultaneous air stripping of VOCs from the circulating groundwater inside the well. The technology usually uses multiple passes of groundwater through the IWVS well to meet the applicable groundwater quality standard before reintroducing the treated groundwater back into the aquifer. Three commercially available versions of this technology were discussed in the Supplemental FS Memorandum (HDR/OBJ JV, 2013). Based on Site specific characteristics there may be advantages to designing the system to meet the NYS Class GA groundwater quality standards with one pass through the IWVS system without relying on the need to form a groundwater circulation cell. A pilot test would be necessary to obtain the ratio of air and water inputs/outputs that would achieve the desired VOC removal efficiency to meet the NYS Class GA groundwater quality standards.

A pilot study for IWVS will be conducted by the Relevant Respondents during this PDI to provide at a minimum the following data for the remedial design:

- IWVS well screen placement/design based on the vertical distribution of VOCs and local stratigraphy.
- The type of treatment equipment to be employed with the IWVS wells.
- Operational settings for the formation of a viable groundwater circulation cell or one-pass stripping well.
- Groundwater extraction and injection rates at the IWVS well screen intervals.
- Susceptibility of the IWVS wells to fouling based on the geochemistry of the circulation zone and any amendments necessary to prevent fouling.
- Total VOC concentrations in the influent, effluent groundwater.
- Off gas flow rate (if applicable).
- Total VOC concentrations in the off-gas (if applicable).
- Total VOC mass removal efficiency.
- Practical zone of influence.

Upon evaluation of total VOC results from new and existing monitoring wells or profile borings (PDI Directive 1) separate IWVS pilot tests will be conducted by the Relevant Respondents in the central and western plumes at OU1 where total VOC concentrations are greater than 100 µg/L but less than 1,000 µg/L. Each test will use a single IWVS well. Existing gamma ray logs from previous investigation boreholes (D&B, 2009) and a new gamma ray log run on the test well boreholes showing the depths of low permeability clays will be considered in the design of the IWVS wells. In addition, the results from grain-size analyses will be used to properly size the slots and filter packs for the IWVS well screens. The IWVS wells will be designed by an experienced geologist or engineer and constructed using PVC or steel, as appropriate. Two or more collocated observation wells will be installed opposite the screen intervals of the IWVS well. Other observation wells (nested, clustered, or multi-ported) will also be appropriately designed and constructed (see Directive 1 for guidance) and closely located (upgradient, downgradient, and cross gradient) at a minimum of an additional three locations to monitor the influence of the pilot test IWVS wells.

At a minimum, baseline groundwater samples will be collected by low flow from the observation wells prior to startup of the pilot test. The baseline samples will be analyzed at a certified laboratory for TCL VOCs by EPA Method 8260 (Table 2) and in the field for pH, electrical conductivity, dissolved oxygen (DO), temperature, and oxidation-reduction potential (ORP). In addition, the baseline samples from the collocated IWVS observation wells will be analyzed at a certified laboratory for total iron, dissolved iron, total hardness, total bacteria count, and presence of iron bacteria.

Each pilot test will be performed for three months and extended if warranted and approved by EPA. Typical system operating and performance parameters will be monitored during the test. Operating parameters may include, but are not limited to: IWVS well instantaneous, daily average, and totalized water flows; off-gas treatment instantaneous, daily average, and totalized air flows; temperature, relative humidity, and line pressures; clean-air relief port flow rate (if present); and system run time. Performance monitoring parameters may include, but are not limited to: frequent (intervals to be specified in the QAPP) depth to water in the IVWS and observation wells measured using vented pressure transducers with onboard dataloggers; weekly system influent and effluent TCL VOC concentrations; weekly system air influent and effluent TCL VOC concentrations; weekly TCL VOC concentrations in condensate knock out tank (if present) samples; and monthly TCL VOC concentrations (Table 2), total iron, dissolved iron, total hardness, total bacteria count, presence of iron bacteria, and field parameters (pH, electrical conductivity, DO, temperature, and ORP) in the observation wells. Relevant Respondents will submit a monthly Pilot Test Status Report to EPA for review and approval that includes a summary of materials, methods, operating and system performance parameters, data trends, conclusions and recommendations.

Deliverables

- Amendments to the QAPP and/or HASP to perform PDI Directive 4 will be submitted for EPA review and approval in accordance with Section 5.7 of the OU1 SOW of any such QAPP amendments, and EPA review of any such HASP amendments.

- A Pilot Test Status Report shall be submitted monthly for each pilot test, which provides a chronological list of all pilot test activities, including but not limited to: 1) a description of all permits, approvals, and variances needed prior to pilot test system installation and startup; 2) a description of any wastes generated during the pilot test system installation/testing and how the waste was handled and disposed; 3) discussion of any problems encountered during the pilot test system installation and operation and how those problems were resolved; 4) an illustration of the pilot test well locations, target zone geometry, geology, and hydrogeology; 5) a description of the pilot test system's major equipment; 6) tables summarizing pilot test well construction details, field and laboratory analytical results, subsurface response monitoring, target zone's physical condition (water levels, pressure, temperature), target zone's chemical condition (VOC concentrations, DO, ORP), and pilot test system operating parameters; and 7) an evaluation of the pilot test data results.

- Pursuant to Section 3.1(b)(4)(ii) of the OU1 SOW, a PDI Directive 4 Technical Memorandum documenting the methods and materials that were used including well construction logs and well location map, a series of tables which summarize the operating parameters, analytical data, test results, findings and recommendations shall be submitted by Relevant Respondents.

PDI Directive 5: In-Situ Chemical Treatment Pilot System Installation and Testing

The total VOCs detected in groundwater at OU1 are amenable to remediation using in-situ chemical oxidation (ISCO) or in-situ chemical reduction (ISCR) processes. ISCO offers rapid destruction of high concentrations of total VOCs; whereas, ISCR does not offer that feature. High concentrations of total VOCs were previously detected in groundwater within the area identified for in-situ chemical treatment in the ROD. Therefore, the discussion presented below is written for the application of ISCO, rather than ISCR, during pilot testing for the remedial design. However, the Relevant Respondents may propose other amendments consistent with the OU1 ROD to be used during the in-situ injection pilot testing for EPA review and approval prior to the testing. Amendments that are selected should minimize any potential risks to nearby residences, commercial buildings, and supply wells.

ISCO Target Zone Delineation

Figure 2 of the OU1 ROD identified the area surrounding well cluster FSMW-14 in the eastern plume as a target zone for in-situ treatment of contaminated groundwater with concentrations (greater than 10,000 µg/L) of total VOCs. Historical data indicate that groundwater containing total VOC concentrations exceeding 10,000 µg/L was last detected in 2011 between 119 and 129 feet deep at FSMW-14A. Groundwater samples from nearby wells FSMW-14B and MW-14 that are screened within intervals of 159 to 169 feet and 185 to 205 feet, respectively, had total VOC concentrations exceeding 10,000 µg/L in 2008 but showed noticeable decreases in concentrations of VOCs by 2011. Additional boreholes will be drilled and the groundwater profiled for total VOCs (Table 2) around FSMW-14A to further define the ISCO treatment zone for the remedial design.

All drilling and sampling activities will be performed using methods that provide continuous samples in a wide range of unconsolidated deposits. Groundwater profile samples from the borings will be collected at 10-foot intervals to provide tighter characterization of the source zone based on sampling intervals previously used in the vicinity (i.e., profiling done at B-9). Sampling will start at the water table and continue through the depth that field screening or laboratory analytical results indicate additional deeper samples are not required. The groundwater samples will be collected by lowering and raising non-dedicated, decontaminated sampling equipment inside the drill casing. Groundwater profile samples will be analyzed by EPA Method 8260 for TCL VOCs listed in Table 2.

The profile boreholes that define the treatment zone will be converted into nested, clustered or multi-port groundwater monitoring wells for future sampling during implementation of the selected remedy. Relevant Respondents shall notify the Remedial Project Manager of the proposed screened intervals for the monitoring wells by telephone and electronic mail for EPA review and approval. The wells shall not be constructed until approved by the EPA. The general materials and methods for installation, development, and surveying of the groundwater monitoring wells were previously described under PDI Directive 2.

Relevant Respondents will submit to EPA for review and approval in accordance with Section 3.1(b)(5) of the OU1 SOW, PDI Directive 5 ISCO Target Zone Delineation Technical Memorandum summarizing the groundwater profiling and laboratory analytical activities and presenting the target zone delineation results. The memorandum will include tabulated analytical results from the profile samples, a figure of profiling locations, a map showing the lateral extent of the ISCO target zone, and cross sections showing the vertical extent of the ISCO target zone.

ISCO Bench Scale Testing

Treatability testing will be performed on homogenized soil and groundwater samples collected from the treatment zone to:

- Verify an oxidant or oxidants for the VOC removal;
- Determine the oxidant demand;
- Evaluation of effectiveness at reducing VOC concentrations; and
- Identify any potential adverse effects and evaluate if there is a means to mitigate those impacts if found to be present.

Prior to the pilot test, Relevant Respondents will submit to EPA for review and approval in accordance with Section 3.1(b)(5) of the OU1 SOW, PDI Directive 5 ISCO Bench Scale Testing Technical Memorandum summarizing the bench scale testing performed on soil and water samples, interpreting the results, identifying any concerns and means to address them, and proposing a work plan for the subsequent pilot test.

ISCO Pilot System Testing

A pilot test will be conducted, using the EPA approved work plan included in the ISCO Bench Scale Testing Technical Memorandum, at an appropriate location within the target zone area that will be delineated as described above. The overall objective of the pilot test is to collect data to evaluate the efficacy of ISCO to treat the higher concentrations of VOCs and to ensure that whatever is done in the field will not harm the aquifer or the public supply wells. The specific objectives of the pilot test are as follows:

- Demonstrate whether ISCO can successfully oxidize and reduce the higher concentrations of VOCs within the target zone.
- Determine oxidant and injection parameters for the remedial design, including type of oxidant, persistence of the oxidant, amendment dosing rates and frequency of required injections.
- Determine the hydraulic parameters for the remedial design including target depth intervals, feasible injection rates, and radius of influence of a single injection well.

- Evaluate the formation and mitigation of secondary water quality factors such as total organic carbon (TOC), sulfate, and dissolved metals (i.e., manganese and iron) to ensure no adverse impacts to the aquifer or public supply wells.

One permanent injection well and three to six nested observation wells will be installed and developed at least one week prior to the pilot test. The equipment required will include a drill rig capable of installing suitable diameter observation and injection wells in wide range of unconsolidated deposits. The observation wells will be appropriately designed and constructed (see guidance for well construction under Directive 2). The injection well shall be appropriately designed and built to properly test the feasibility of ISCO at OU1. The design radius of influence (ROI) for the pilot study will be at least 10 feet. The observation wells will be spread around the injection well at varied distances within the ROI in the assumed direction of oxidant flow and the observation well screen intervals will be at staggered depths to assess the lateral and vertical distribution of the oxidant during the pilot test. IDW generated during the well installation activities will be properly contained, characterized, and disposed as described in the QAPP.

The groundwater monitoring program established for the pilot study consists of three sampling periods:

- Low-flow baseline sampling of the pilot study wells (injection and observation) to be conducted before commencing any injection activities. The baseline samples will be analyzed at a certified laboratory for TCL VOCs (EPA Method 8260), dissolved TAL metals (EPA Method 6010B) including hexavalent chromium (SW-846 7000 series), and any secondary constituents of concern and in the field for DO (meter/flow cell), temperature (meter/flow cell), pH (meter/flow cell), ORP (meter/flow cell), and electrical conductivity (meter/flow cell).

- Injection performance sampling of the pilot study wells (injection and observation) to be conducted regularly for field parameters (pH, temperature, electrical conductivity, ORP, and DO) plus analysis using appropriate visual indicators, laboratory methods or test kits for presence of the oxidant(s) being injected. It is anticipated that the oxidant will be injected in one dose at a rate that will not mobilize the VOCs plume.

- Post-injection performance sampling of the pilot study wells (injection and observation) for the same parameters as the baseline and injection performance monitoring. Details of sampling program will be provided in QAPP and at a minimum, the sampling events will be conducted 1 week, 2 weeks, 4 weeks, 8 weeks, and 12 weeks following the end of injection.

Water level measurements and other data associated with the oxidant delivery hydraulics will be collected during the injection process. Water level measurements will be automatically collected at the injection and observation wells using pressure transducers with onboard dataloggers. The measurement will be made prior to starting the injection, during the injection, and following completion of the injection test. Other data to be collected during the injection phase includes:

- Injection solution flow rate.

- Wellhead injection pressure.

- Temperature, pH, and electrical conductivity of the injection solution.

- Cumulative volume of the injection solution delivered to the injection well.

A UIC inventory form (EPA Form 7620-18) containing injection well information will be submitted to the UIC branch of EPA Region 2 for a determination on permitting requirements prior to commencing any injections.

Deliverables

- Amendments to the QAPP and/or HASP to perform PDI Directive 5 will be submitted for EPA review and approval in accordance with Section 5.7 of the OU1 SOW of any such QAPP amendments, and EPA review of any such HASP amendments.
- Relevant Respondents will submit to EPA for review and approval in accordance with Section 3.1(b)(5) of the OU1 SOW, PDI Directive 5 ISCO Target Zone Delineation Technical Memorandum summarizing the ISCO target zone delineation.
- Relevant Respondents will submit to the EPA for review and approval in accordance with Section 3.1(b)(5) of the OU1 SOW, prior to the pilot test, an ISCO Bench Scale Testing Technical Memorandum summarizing the bench scale testing.
- Relevant Respondents will concurrently submit the ISCO Pilot Test Work Plan and the ISCO Bench Scale Testing Technical Memorandum for EPA review and approval in accordance with Section 3.1(b)(5).
- Relevant Respondents will submit for EPA review and approval in accordance with Section VI of the OU1 SOW and Section 3.1(b)(5)(ii), a PDI Directive 5 Technical Memorandum which will document the methods and materials that were used for the ISCO Pilot Test including well construction logs and well location map, a series of tables which summarize the operating parameters, analytical data, test results and presents findings and recommendations.

SCHEDULE OF DELIVERABLES

A schedule of deliverables to be submitted by the Respondents to the EPA during this PDI is provided in Section 6.2 of the OU1 SOW.

REFERENCES

Dvirka and Bartilucci Consulting Engineers (D&B), 2009, Pre-Design Investigation Report, New Cassel Industrial Area Site, Operable Unit No. 3, Site No. 1-30-043, Town of North Hempstead, Nassau County, New York, June 2009.

Henningson, Durham & Richardson Architecture and Engineering, P.C. (HDR), 2011, Pre-Design Investigation Report, New Cassel Industrial Area, Offsite Groundwater OU3, August 2011.

HDR and O'Brien & Gere (HDR/OBG JV), 2013, Supplemental Feasibility Study, Technical Memorandum for Operable Unit 1 for the New Cassel/Hicksville Groundwater Contamination Superfund Site, Nassau County, New York, July 2013.

TABLES

FIGURES

APPENDICES

TABLES

New Cassel/Hicksville Groundwater Contamination Site – OU1

TABLE 1
Well Construction Details
New Cassel/Hicksville Ground Water Contamination Site - OU1
Nassau County, NY

Well Number	Northing (feet)	Easting (feet)	TOC or GS Elev. (ft-amsl)	Screen/Sample Interval		Status	Comments
				Top (ft-bgs)	Bottom (ft-bgs)		
Permanent Monitoring and Extraction Wells							
EW-1B	214139.02	1106606.83	113.84	154	164	Active	
EW-1C	214133.38	1106591.29	113.99	506	516	Active	
EW-2B	214176.02	1105922.15	114.88	132	142	Active	
EW-2C	214169.96	1105910.27	114.80	504	514	Active	
EX-1	213894.38	1107322.85	107.71	185	205	Active	Groundwater extraction well.
EX-2	212587.22	1103835.27	105.47	265	285	Active	Groundwater extraction well.
FSMW-13A	214665.46	1107432.23	117.74	69	79	Active	
FSMW-13B	214659.28	1107433.80	117.77	119	129	Active	
FSMW-13C	214651.61	1107436.15	117.66	239	249	Active	
FSMW-14A	214580.13	1107262.83	116.99	119	129	Active	
FSMW-14B	214582.56	1107256.69	117.18	159	169	Active	
FSMW-14C	214584.35	1107249.01	116.97	239	249	Active	
MW-1	213450.19	1105300.86	113.67	90	110	Active	
MW-2	213453.60	1105304.62	113.69	110	130	Active	
MW-3	213456.32	1105307.42	113.67	130	150	Active	
MW-4	213460.96	1105312.86	113.76	180	200	Active	
MW-5	213806.40	1105650.97	115.64	90	110	Active	
MW-6	213802.99	1105653.58	115.70	110	130	Active	
MW-7	211946.79	1104331.50	105.92	90	110	Active	
MW-8	211947.25	1104337.36	105.85	120	140	Active	
MW-9	212954.47	1105703.40	109.94	310	315	Active	
MW-10	213449.23	1105233.35	113.05	275	285	Active	
MW-11S	212056.64	1104018.49	106.96	215	225	Active	
MW-11D	212056.64	1104018.49	106.96	275	285	Active	
MW-12	212461.12	1103100.39	104.70	215	225	Active	
MW-13	211667.02	1103498.73	105.26	200	210	Active	
MW-14	214120.66	1107347.51	111.85	185	205	Active	
MW-15	213749.98	1106780.90	111.03	185	205	Active	

TABLE 1
Well Construction Details
New Cassel/Hicksville Ground Water Contamination Site - OU1
Nassau County, NY

Well Number	Northing (feet)	Easting (feet)	TOC or GS Elev. (ft-amsl)	Screen/Sample Interval		Status	Comments
				Top (ft-bgs)	Bottom (ft-bgs)		
MW-16S	213313.45	1106226.97	109.04	215	225	Active	
MW-16D	213313.45	1106226.97	109.07	275	285	Active	
MW-17S	213282.84	1107304.77	113.90	215	225	Active	
MW-17D	213282.84	1107304.77	113.87	275	285	Active	
Temporary Monitoring Wells							
TMW-1	212023.94	1103888.96	NA	72	285	Inactive	Sampled at generally 10- to 20-foot intervals from temporary monitor wells.
TMW-2	212826.11	1103638.25	NA	65	285	Inactive	Sampled at generally 20-foot intervals from temporary monitor wells.
TMW-3D	212720.39	1104659.48	NA	52	502	Inactive	Sampled at generally 20-foot intervals from temporary monitor wells.
TMW-4	212458.05	1105294.74	NA	65	285	Inactive	Sampled at 20-foot intervals from temporary monitor wells.
TMW-5	213463.41	1105545.03	NA	65	285	Inactive	Sampled at 20-foot intervals from temporary monitor wells.
TMW-6	214301.81	1106269.29	NA	63	283	Inactive	Sampled at 20-foot intervals from temporary monitor wells.
TMW-7	214207.61	1107381.31	NA	65	285	Inactive	Sampled at 20-foot intervals from temporary monitor wells.
TMW-8D	213297.60	1106240.24	NA	52	502	Inactive	Sampled at generally 20-foot intervals from temporary monitor wells.
TMW-9	213417.25	1104512.43	NA	60	280	Inactive	Sampled at 20-foot intervals from temporary monitor wells.

Notes
TOC = top of casing; GS = ground surface; NA = not available
ft-amsl = feet above mean sea level
ft-bgs = feet below ground surface
Vertical datum = NAVD 88
Coordinate system = NAD83 New York State Plane, Long Island Zone

TABLE 2
Target Compound List for Volatile Organic Compounds
New Cassel/Hicksville Ground Water Contamination Site - OU1
Nassau County, NY

Analyte	CAS Number	NYSDEC Water Quality Standard (µg/L)	Federal Maximum Contaminant Level (µg/L)
Dichlorodifluoromethane	75-71-8	5	NS
Chloromethane	74-87-3	NS	NS
Vinyl Chloride	75-01-4	2	2
Bromomethane	74-83-9	5	NS
Chloroethane	75-00-3	5	NS
Trichlorofluoromethane	75-69-4	5	NS
1,1-Dichloroethene	75-35-4	5	7
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	5	NS
Acetone	67-64-1	NS	NS
Carbon Disulfide	75-15-0	60	NS
Methyl Acetate	79-20-9	NS	NS
Methylene Chloride	75-09-2	5	5
trans-1,2-Dichloroethene	156-60-5	5	100
Methyl tert-Butyl Ether	1634-04-4	NS	NS
1,1-Dichloroethane	75-34-3	5	NS
cis-1,2-Dichloroethene	156-59-2	5	70
2-Butanone (MEK)	78-93-3	NS	NS
Chloroform	67-66-3	7	80
1,1,1-Trichloroethane	71-55-6	5	200
Cyclohexane	110-82-7	NS	NS
Carbon Tetrachloride	56-23-5	5	5
Benzene	71-43-2	1	5
1,2-Dichloroethane	107-06-2	0.6	5
Trichloroethene	79-01-6	5	5
Methylcyclohexane	108-87-2	NS	NS
Bromodichloromethane	75-27-4	5	80
1,2-Dichloropropane	78-87-5	1	5
Toluene	108-88-3	5	1000
trans-1,3-Dichloropropene	10061-02-6	0.4	NS
cis-1,3-Dichloropropene	10061-01-5	NS	NS
4-Methyl-2-Pentanone	108-10-1	NS	NS
1,1,2-Trichloroethane	79-00-5	1	5
Tetrachloroethene	127-18-4	5	5
2-Hexanone	591-78-6	NS	NS
Dibromochloromethane	124-48-1	NS	80
1,2-Dibromoethane	106-93-4	NS	500
Chlorobenzene	108-90-7	5	100
Ethylbenzene	100-41-4	5	700
Xylenes (total)	1330-20-7	5	NS
Styrene	100-42-5	5	100
Bromoform	75-25-2	NS	80
Isopropylbenzene	98-82-8	5	NS
1,1,2,2-Tetrachloroethane	79-34-5	5	NS
1,3-Dichlorobenzene	541-73-1	5	NS
1,4-Dichlorobenzene	106-46-7	5	75
1,2-Dichlorobenzene	95-50-1	5	600
1,2-Dibromo-3-chloropropane	96-12-8	0.04	20
1,2,4-Trichlorobenzene	120-82-1	5	70
1,4-Dioxane	123-91-1	NS	NS

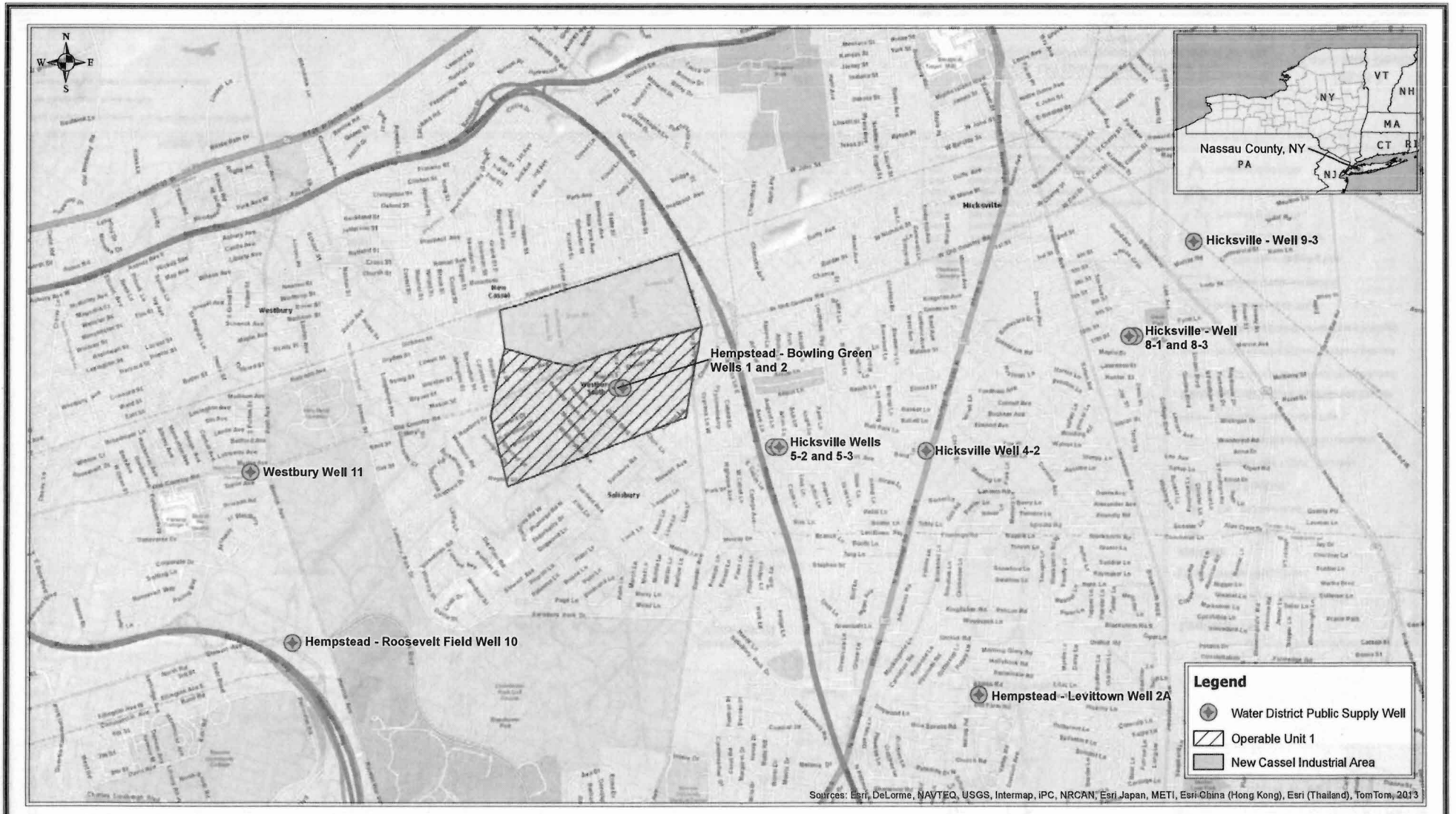
NYSDEC = New York State Department of Environmental Conservation
ROD = Record of Decision
µg/L = micrograms per liter
NS = no standard

TABLE 3
Groundwater Profiling Boreholes and Monitoring Wells Specifications
New Cassel/Hicksville Ground Water Contamination Site - OU1
Nassau County, NY

Transect No.	Location	No. of Wells at Location	Nearby Existing Wells	Approx. Number of Groundwater Profile Samples	Profile Interval (ft-bgs)	Maximum Depth of Borehole (ft-bgs)	Approximate Targeted Screen Zones	Rationale
T1	**MW-19**	1	None	0	NS	220	1I	Installation of this monitoring well may be necessary to obtain design parameters pending the results of PDI-20 and PDI-22. Data from this well would be used to design the northwestern portion of the western treatment area.
T1	PDI-20/MW-20	3	None	12	40,100-300	300	1S/1I/1D	Obtain data necessary to design treatment well screens including depth intervals, overall length, and to demarcate the 100-ppb ROD benchmark boundary(s) required to optimize the design for the northern portion of the western treatment area. Intermediate well - Obtain data to optimize treatment well placement both horizontally and vertically. Shallow well - Obtain data to confirm the top of the treatment zone. Deep well - Obtain data to confirm the bottom of the treatment zone.
T1	**MW-21**	1	TMW-9	0	NS	220	1I	Installation of this monitoring well may be necessary to obtain design parameters pending the results of PDI-20 and MW-24. Data from this well would be used to design the northeastern portion of the western treatment area.
T2	PDI-22/MW-22	3	TMW-2	9	40, 260-400	400	1S/1I/1D	Obtain data necessary to design treatment well screens including depth intervals, overall length, and to demarcate the 100-ppb ROD benchmark boundary(s) required to optimize the design along the western margin of the central portion of the western treatment area. Nearby TMW-2 had significant concentrations down to depth, PDI-22 will go deeper than TMW-2. Intermediate well - Obtain data to optimize treatment well placement both horizontally and vertically. Shallow well - Obtain data to confirm the top of the treatment zone. Deep well - Obtain data to confirm the bottom of the treatment zone.
T2	PDI-23/MW-23	3	EX-2	20	40, 100-440	440	1S/1I/1D	Obtain data necessary to design treatment well screens including depth intervals, overall length, and to demarcate the 100-ppb ROD benchmark boundary(s) required to optimize the design of the central portion of the western treatment area. Intermediate well - Obtain data to optimize treatment well placement both horizontally and vertically. Shallow well - Obtain data to confirm the top of the treatment zone. Deep well - Obtain data to confirm the bottom of the treatment zone.
T2	**MW-24**	1	TMW-3D	0	NS	370	1D	Installation of this monitoring well may be necessary to obtain design parameters pending the results of PDI-23. Obtain data to optimize the design along the eastern margin of the central portion of the western treatment area.
T2	**MW-25**	1	MW-12, TMW-1	0	310	310	1D	Installation of this monitoring well may be necessary to obtain design parameters pending the results of PDI-22. Obtain data to optimize the design along the western margin of the central portion of the western treatment area.
T3	MW-26	1	MW-13	0	NS	310	1D	Obtain data necessary to determine required radius of influence for extraction wells, design pumping rates, and to confirm capture of the 100-ppb ROD benchmark boundary required to optimize the design of the southern portion of western treatment area.
T3	PDI-27/MW-27	3	None	20	40, 100-460	460	1S/1I/1D	Obtain data necessary to design treatment well screens including depth intervals, overall length, and to demarcate the 100-ppb ROD benchmark boundary(s) required to optimize the design of the southern portion of the western treatment area. Intermediate well - Obtain data to optimize treatment well placement both horizontally and vertically. Shallow well - Obtain data to confirm the top of the treatment zone. Deep well - Obtain data to confirm the bottom of the treatment zone.
T3	PDI-28/MW-28	2	MW-7, MW-8	12	40, 200-400	May need to extend up to 500 feet deep based on TMW-3 results	1I/1D (may be additional deep wells)	Obtain data necessary to design treatment well screens including depth intervals, overall length, and to demarcate the 100-ppb ROD benchmark boundary(s) required to optimize the design along the eastern margin of the southern portion of the western treatment area. Based on the uppradient TMW-3 results, a deeper well is needed. Intermediate well - Obtain data to optimize treatment well placement both horizontally and vertically. Deep well - Obtain data to confirm the bottom of the treatment zone.
T4	MW-29	1	None	0	NS	220	1I	Obtain data necessary to demarcate the 100-ppb ROD benchmark boundary required to optimize the design the northern portion of the central treatment area.
T4	PDI-30/MW-30	3	MW-5, MW-6	15	40, 80-340	340	1S/1I/1D	Obtain data necessary to design treatment well screens including depth intervals, overall length, and to demarcate the 100-ppb ROD benchmark boundary(s) required to optimize the design. Intermediate well - Obtain data to optimize treatment well placement both horizontally and vertically. Shallow well - Obtain data to confirm the top of the treatment zone. Deep well - Obtain data to confirm the bottom of the treatment zone.
T4	**MW-31**	1	MW-5, MW-6	0	NS	220	1I	Installation of this monitoring well may be necessary to obtain design parameters pending the results of PDI-30. Obtain data along the eastern margin to optimize the design of the northern portion of the central treatment system.
T5	PDI-32/MW-32	3	MW-1 to MW-4, MW-10	16	40-340	340	1S/1I/1D	Obtain data necessary to design treatment well screens including depth intervals, overall length, and to demarcate the 100-ppb ROD benchmark boundary(s) required to optimize the design for the central portion of the central treatment area. Intermediate well - Obtain data to optimize treatment well placement both horizontally and vertically. Shallow well - Obtain data to confirm the top of the treatment zone. Deep well - Obtain data to confirm the bottom of the treatment zone.
T5	**MW-33**	2	TMW-5	0	NS	340	1S/1D	Installation of this monitoring well may be necessary to obtain design parameters pending the results of PDI-32. Obtain data along the eastern margin to optimize the design along the central portion of the central treatment system.
T6	**MW-34**	1	None	0	NS	260	1I	Installation of this monitoring well may be necessary to obtain design parameters pending the results of PDI-35. Obtain data along the western margin to design the southern portion of the central treatment system.
T6	PDI-35/MW-35	3	None	17	40, 100-400	400	1S/1I/1D	To obtain data necessary to design treatment well screens including depth intervals, overall length, and to demarcate the 100-ppb ROD benchmark boundary(s) required to optimize the design for the southern portion of the central treatment area. Intermediate well - Obtain data to optimize treatment well placement both horizontally and vertically. Shallow well - Obtain data to confirm the top of the treatment zone. Deep well - Obtain data to confirm the bottom of the treatment zone.
T6	MW-36	1	None	0	NS	260	1I	Installation of this monitoring well may be necessary to obtain design parameters pending the results of PDI-35. Obtain data along the eastern margin to optimze the design along the southern portion of the central treatment system.
T7	**MW-37**	1	None	0	NS	160	1S	Installation of this monitoring well may be necessary to obtain design parameters pending the results of PDI-38 and MW-40. Obtain data to along the western margin of the eastern treatment area in order to optimize the design along the northern portion of the eastern treatment system.
T7	PDI-38/MW-38	4	None	15	40-320	320	2S/1I/1D	Obtain data necessary to design treatment well screens including depth intervals, overall length, and to demarcate the 100-ppb ROD benchmark boundary(s) required to optimize the design for the northern portion of the eastern treatment area. Intermediate well - Obtain data to optimize treatment well placement both horizontally and vertically. Shallow wells - Obtain data to confirm the top of the treatment zone. Deep well - Obtain data to confirm the bottom of the treatment zone.
T7	**MW-39**	1	B-9	0	NS	160	1S	Installation of this monitoring well may be necessary to obtain design parameters pending the results of PDI-38 and MW-42. Obtain data to along the eastern margin of the eastern treatment area in order to optimize the design along the northern portion of the eastern treatment system.
T8	MW-40	1	EX-1	0	NS	230	1I	Obtain data necessary to design treatment well screens including depth intervals, overall length, and to demarcate the 100-ppb ROD benchmark boundary(s) required to optimize the design along the western margin for the central portion of the eastern treatment area.
T8	PDI-41/MW-41	2	EX-1	12	40, 120-320	320	2D	Obtain data necessary to design treatment well screens including depth intervals, overall length, and to demarcate the 100-ppb ROD benchmark boundary(s) required to optimize the design for the central portion of the eastern treatment area. Intermediate well - The existing EX-1 well can serve as the intermediate well. Deep wells - Obtain data to confirm the bottom of the treatment zone.
T8	MW-42	1	EX-1	0	NS	230	1I	Obtain data necessary to determine required radius of influence for extraction wells, design pumping rates, and to confirm capture of the 100-ppb ROD benchmark boundary required to optimize the design along the eastern margin of the central portion of the eastern treatment area. Note: TMW-7 has ~11,000 ppb of PCE.
T9	MW-43	1	MW-17	0	NS	320	1D	Obtain data necessary to determine required radius of influence for extraction wells, design pumping rates, and to confirm capture of the 100-ppb ROD benchmark boundary required to optimize the design along the western margin of the southern portion of the eastern treatment area.
T9	PDI-44/MW-44	1	MW-17	9	40, 220-360	360	1D	Obtain data necessary to design treatment well screens including depth intervals, overall length, and to demarcate the 100-ppb ROD benchmark boundary(s) required to optimize the design for the southern portion of the eastern treatment area. Intermediate well - The existing MW-17D well can serve as the intermediate well. Shallow well - The existing MW-17S well can serve as the shallow well. Deep well - Obtain data to confirm the bottom of the treatment zone.
T9	MW-45	1	MW-17	0	NS	320	1D	Obtain data necessary to determine required radius of influence for extraction wells, design pumping rates, and to confirm capture of the 100-ppb ROD benchmark boundary required to optimize the design along the eastern margin of the southern portion of the eastern treatment area.

Notes:
ft-bgs = feet below ground surface
* Water table estimated to be at a depth of 40 feet. Profiling should extend to the total depth indicated, unless screening results indicate deeper samples are necessary.
Targeted screen zones:
S = shallow well screened < 175 ft-bgs
I= intermediate well screened between 175 and 250 ft-bgs
D = deep well screened >250 ft-bgs
NS = not sampled
VPB = vertical profile borehole
Centerline vertical profile boreholes will be completed first to guide in setting screens in the monitoring wells and sampling depths in the profile boreholes.
The locations of Transects T1 through T9 intersecting lines of IWVS or groundwater extraction wells within the plumes are shown on Figure 3.
"Optional wells" are highlighted in red. Following the VOC concentration profiling results, a determination will be made as to whether installation of these wells is necessary to obtain design parameters.

FIGURES
New Cassel/Hicksville Groundwater Contamination Site – OU1



Base map created using ESRI World Street Map.

Map Creation Date: 25 August 2015

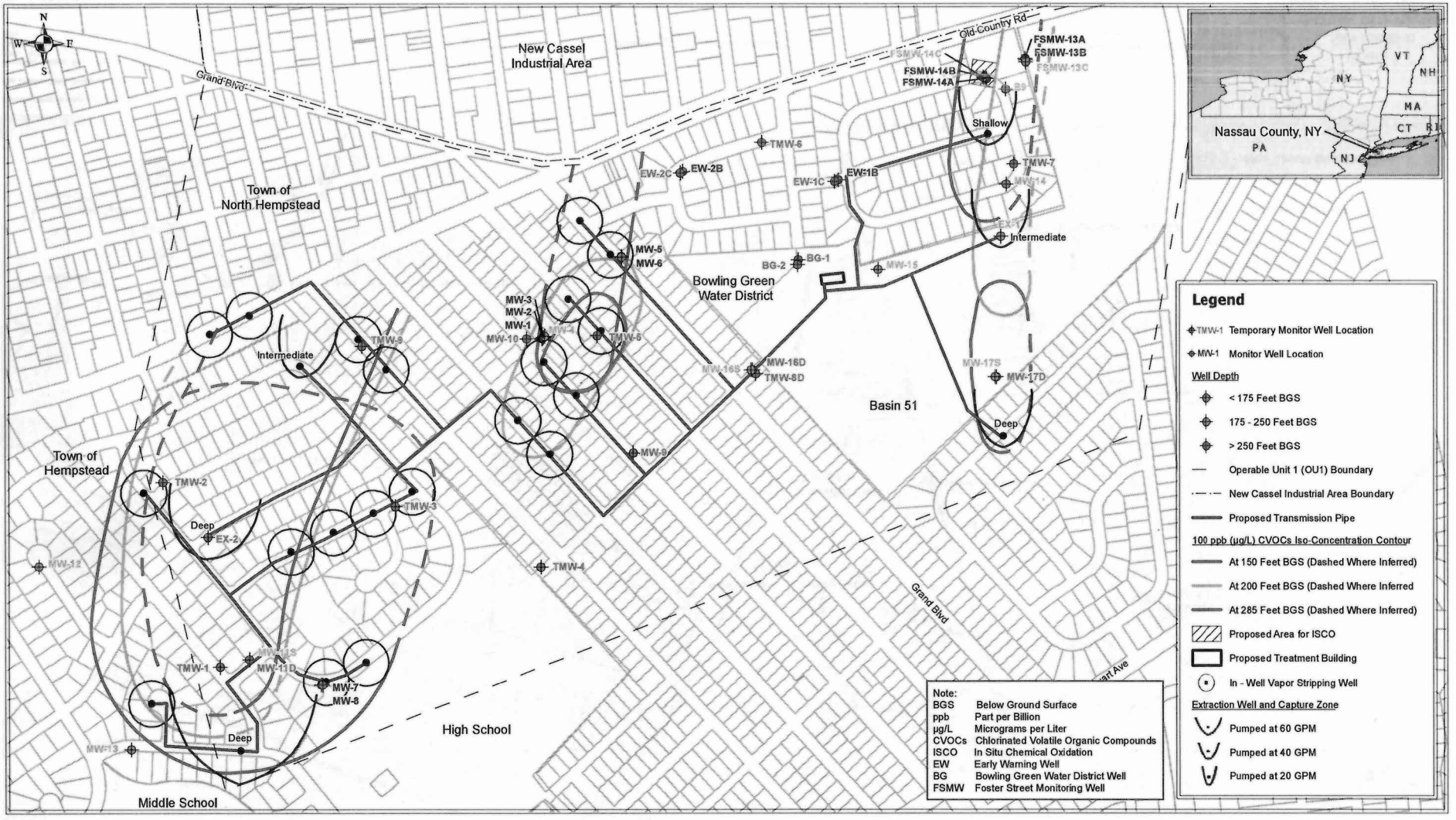
Coordinate system: New York State Plane Long Island
FIPS: 3104
Datum: NAD83
Units: Feet

0 2,000 4,000 Feet

Data: g:\arcviewprojects\SERAS01\00-275
MXD file: g:\arcinfoprojects\SERAS01\SER00275_New_Cassel_PRD\275_TM2015_Site_Locations_f1.mxd

U.S. EPA Environmental Response Team
Scientific Engineering Response and Analytical Services
EP-W-09-031
W.A.# 0-275

Figure 1
Site Location
NCHGW OU1 PDI WP
Nassau County, New York



Base map created using parcels map, other data from HDR CAD file.

Map Creation Date: 25 August 2015

Coordinate system: New York State Plane Long Island
FIPS: 3104
Datum: NAD83
Units: Feet

Data: g:\arcviewprojects\SERAS01\00-275
MXD file: g:\arcinfoprojects\SERAS01\SER00275_New_Cassel_PRD\275_TM2015_SelectedRemedy_f2.mxd

0 400 800 Feet

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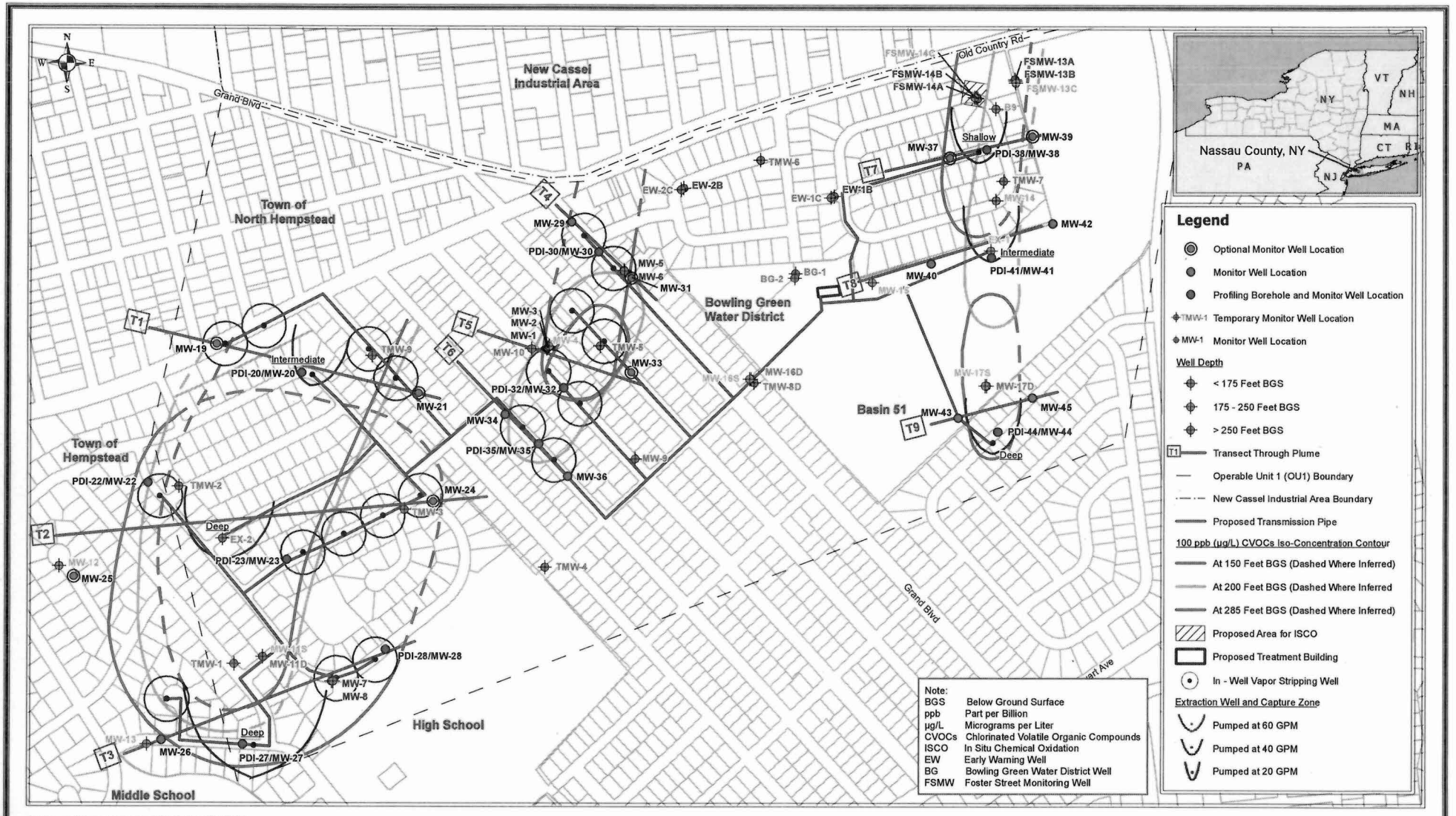
Scientific Engineering Response and Analytical Services
EP-W-09-031
W.A.# 0-275

Figure 2
Conceptual Design
Selected Remedy
NCHGW OU1



Base map created using parcels map, other data from HDR CAD file.

Map Creation Date: 25 August 2015

Coordinate system: New York State Plane Long Island
FIPS: 3104
Datum: NAD83
Units: Feet

Data: g:\arcviewprojects\SERAS01\00-275
MXD file: g:\arcinfoprojects\SERAS01\SER00275_New_Cassel_PRD\275_TM2015_GW_PBorehole_MW_Locations_f3.mxd

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EP-W-09-031
W.A.# 0-275

Figure 3
Groundwater Profiling Boreholes and Monitor Well Locations
NCHGW OU1 PDI WP
Nassau County, New York

APPENDIX A

EPA Region II Groundwater Sampling Procedure Low Stress (Low Flow)
Purging and Sampling

APPENDIX A

EPA Region II Groundwater Sampling Procedure Low Stress (Low Flow)
Purging and Sampling
New Cassel/Hicksville Groundwater Contamination Site - OU1
Technical Memorandum

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION II

GROUND WATER SAMPLING PROCEDURE
LOW STRESS (Low Flow) PURGING AND SAMPLING

I. SCOPE & APPLICATION

This Low Stress (or Low-Flow) Purging and Sampling Procedure is the EPA Region II standard method for collecting low stress (low flow) ground water samples from monitoring wells. Low stress Purging and Sampling results in collection of ground water samples from monitoring wells that are representative of ground water conditions in the geological formation. This is accomplished by minimizing stress on the geological formation and minimizing disturbance of sediment that has collected in the well. The procedure applies to monitoring wells that have an inner casing with a diameter of 2.0 inches or greater, and maximum screened intervals of ten feet unless multiple intervals are sampled. The procedure is appropriate for collection of ground water samples that will be analyzed for volatile and semi-volatile organic compounds (VOCs and SVOCs), pesticides, polychlorinated biphenyls (PCBs), metals, and microbiological and other contaminants in association with all EPA programs.

This procedure does not address the collection of light or dense non-aqueous phase liquids (LNAPL or DNAPL) samples, and should be used for aqueous samples only. For sampling NAPLs, the reader is referred to the following EPA publications: DNAPL Site Evaluation (Cohen & Mercer, 1993) and the RCRA Ground-Water Monitoring: Draft Technical Guidance (EPA/530-R-93-001), and references therein.

II. METHOD SUMMARY

The purpose of the low stress purging and sampling procedure is to collect ground water samples from monitoring wells that are representative of ground water conditions in the geological formation. This is accomplished by setting the intake velocity of the sampling pump to a flow rate that limits drawdown inside the well casing.

Sampling at the prescribed (low) flow rate has three primary benefits. First, it minimizes disturbance of sediment in the bottom of the well, thereby producing a sample with low turbidity (i.e., low concentration of suspended particles). Typically, this saves time and analytical costs by eliminating the need for collecting and analyzing an additional filtered sample from the same well. Second, this procedure

minimizes aeration of the ground water during sample collection, which improves the sample quality for VOC analysis. Third, in most cases the procedure significantly reduces the volume of ground water purged from a well and the costs associated with its proper treatment and disposal.

III. ADDRESSING POTENTIAL PROBLEMS

Problems that may be encountered using this technique include a) difficulty in sampling wells with insufficient yield; b) failure of one or more key indicator parameters to stabilize; c) cascading of water and/or formation of air bubbles in the tubing; and d) cross-contamination between wells.

Insufficient Yield

Wells with insufficient yield (i.e., low recharge rate of the well) may dewater during purging. Care should be taken to avoid loss of pressure in the tubing line due to dewatering of the well below the level of the pump's intake. Purging should be interrupted before the water level in the well drops below the top of the pump, as this may induce cascading of the sand pack. Pumping the well dry should therefore be avoided to the extent possible in all cases. Sampling should commence as soon as the volume in the well has recovered sufficiently to allow collection of samples. Alternatively, ground water samples may be obtained with techniques designed for the unsaturated zone, such as lysimeters.

Failure to Stabilize Key Indicator Parameters

If one or more key indicator parameters fails to stabilize after 4 hours, one of three options should be considered: a) continue purging in an attempt to achieve stabilization; b) discontinue purging, do not collect samples, and document attempts to reach stabilization in the log book; c) discontinue purging, collect samples, and document attempts to reach stabilization in the log book; or d) Secure the well, purge and collect samples the next day (preferred). The key indicator parameter for samples to be analyzed for VOCs is dissolved oxygen. The key indicator parameter for all other samples is turbidity.

Cascading

To prevent cascading and/or air bubble formation in the tubing, care should be taken to ensure that the flow rate is sufficient to maintain pump suction. Minimize the length and diameter of tubing (i.e., 1/4

or 3/8 inch ID) to ensure that the tubing remains filled with ground water during sampling.

Cross-Contamination

To prevent cross-contamination between wells, it is strongly recommended that dedicated, in-place pumps be used. As an alternative, the potential for cross-contamination can be reduced by performing the more thorough "daily" decontamination procedures between sampling of each well in addition to the start of each sampling day (see Section VII, below).

Equipment Failure

Adequate equipment should be on-hand so that equipment failures do not adversely impact sampling activities.

IV. PLANNING DOCUMENTATION AND EQUIPMENT

- Approved site-specific Field Sampling Plan/Quality Assurance Project Plan (QAPP). This plan must specify the type of pump and other equipment to be used. The QAPP must also specify the depth to which the pump intake should be lowered in each well. Generally, the target depth will correspond to the mid-point of the most permeable zone in the screened interval. Borehole geologic and geophysical logs can be used to help select the most permeable zone. However, in some cases, other criteria may be used to select the target depth for the pump intake. In all cases, the target depth must be approved by the EPA hydrogeologist or EPA project scientist.

- Well construction data, location map, field data from last sampling event.

- Polyethylene sheeting.

- Flame Ionization Detector (FID) and Photo Ionization Detector (PID).

- Adjustable rate, positive displacement ground water sampling pump (e.g., centrifugal or bladder pumps constructed of stainless steel or Teflon). A peristaltic pump may only be used for inorganic sample collection.

- Interface probe or equivalent device for determining the presence or absence of NAPL.

- Teflon or Teflon-lined polyethylene tubing to collect samples for organic analysis. Teflon or Teflon-lined polyethylene, PVC, Tygon or polyethylene tubing to collect samples for inorganic analysis. Sufficient tubing of the appropriate material must be available so that each well has dedicated tubing.

- Water level measuring device, minimum 0.01 foot accuracy, (electronic preferred for tracking water level drawdown during all pumping operations).

- Flow measurement supplies (e.g., graduated cylinder and stop watch or in-line flow meter).

- Power source (generator, nitrogen tank, etc.).
- Monitoring instruments for indicator parameters. Eh and dissolved oxygen must be monitored in-line using an instrument with a continuous readout display. Specific conductance, pH, and temperature may be monitored either in-line or using separate probes. A nephalometer is used to measure turbidity.

- Decontamination supplies (see Section VII, below).

- Logbook (see Section VIII, below).

- Sample bottles.

- Sample preservation supplies (as required by the analytical methods).

- Sample tags or labels, chain of custody.

V. SAMPLING PROCEDURES

Pre-Sampling Activities

1. Start at the well known or believed to have the least contaminated ground water and proceed systematically to the well with the most contaminated ground water. Check the well, the lock, and the locking cap for damage or evidence of tampering. Record observations.

2. Lay out sheet of polyethylene for placement of monitoring and sampling equipment.

3. Measure VOCs at the rim of the unopened well with a PID and FID instrument and record the reading in the field log book.

4. Remove well cap.

5. Measure VOCs at the rim of the opened well with a PID and an FID instrument and record the reading in the field log book.

6. If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one. Note that the reference point should be surveyed for correction of ground water elevations to the mean geodesic datum (MSL).

7. Measure and record the depth to water (to 0.01 ft) in all wells to be sampled prior to purging. Care should be taken to minimize disturbance in the water column and dislodging of any particulate matter attached to the sides or settled at the bottom of the well.

8. If desired, measure and record the depth of any NAPLs using an interface probe. Care should be taken to minimize disturbance of any sediment that has accumulated at the bottom of the well. Record the observations in the log book. If LNAPLs and/or DNAPLs are detected, install the pump at this time, as described in step 9, below. Allow the well to sit for several days between the measurement or sampling of any DNAPLs and the low-stress purging and sampling of the ground water.

Sampling Procedures

9. Install Pump: Slowly lower the pump, safety cable, tubing and electrical lines into the well to the depth specified for that well in the EPA-approved QAPP or a depth otherwise approved by the EPA hydrogeologist or EPA project scientist. The pump intake must be kept at least two (2) feet above the bottom of the well to prevent disturbance and resuspension of any sediment or NAPL present in the bottom of the well. Record the depth to which the pump is lowered.

10. Measure Water Level: Before starting the pump, measure the water level again with the pump in the well. Leave the water level measuring device in the well.

11. Purge Well: Start pumping the well at 200 to 500 milliliters per minute (ml/min). The water level should be monitored approximately every five minutes. Ideally, a steady flow rate should be maintained that results in a stabilized water

level (drawdown of 0.3 ft or less). Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. As noted above, care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment.

12. Monitor Indicator Parameters: During purging of the well, monitor and record the field indicator parameters (turbidity, temperature, specific conductance, pH, Eh, and DO) approximately every five minutes. The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows (Puls and Barcelona, 1996):

    ±0.1 for pH
    ±3% for specific conductance (conductivity)
    ±10 mv for redox potential
    ±10% for DO and turbidity

    Dissolved oxygen and turbidity usually require the longest time to achieve stabilization. The pump must not be removed from the well between purging and sampling.

13. Collect Samples: Collect samples at a flow rate between 100 and 250 ml/min and such that drawdown of the water level within the well does not exceed the maximum allowable drawdown of 0.3 ft. VOC samples must be collected first and directly into sample containers. All sample containers should be filled with minimal turbulence by allowing the ground water to flow from the tubing gently down the inside of the container.

    Ground water samples to be analyzed for volatile organic compounds (VOCs) require pH adjustment. The appropriate EPA Program Guidance should be consulted to determine whether pH adjustment is necessary. If pH adjustment is necessary for VOC sample preservation, the amount of acid to be added to each sample vial prior to sampling should be determined, drop by drop, on a separate and equal volume of water (e.g., 40 ml). Ground water purged from the well prior to sampling can be used for this purpose.

14. Remove Pump and Tubing: After collection of the samples, the tubing, unless permanently installed, must be properly discarded or dedicated to the well for resampling by hanging the tubing inside the well.

15. Measure and record well depth.

16. Close and lock the well.

VI. FIELD QUALITY CONTROL SAMPLES

Quality control samples must be collected to determine if sample collection and handling procedures have adversely affected the quality of the ground water samples. The appropriate EPA Program Guidance should be consulted in preparing the field QC sample requirements of the site-specific QAPP.

All field quality control samples must be prepared exactly as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples should be collected during the sampling event:

- Field duplicates
- Trip blanks for VOCs only
- Equipment blank (not necessary if equipment is dedicated to the well)

As noted above, ground water samples should be collected systematically from wells with the lowest level of contamination through to wells with highest level of contamination. The equipment blank should be collected after sampling from the most contaminated well.

VII. DECONTAMINATION

Non-disposable sampling equipment, including the pump and support cable and electrical wires which contact the sample, must be decontaminated thoroughly each day before use ("daily decon") and after each well is sampled ("between-well decon"). Dedicated, in-place pumps and tubing must be thoroughly decontaminated using "daily decon" procedures (see #17, below) prior to their initial use. For centrifugal pumps, it is strongly recommended that non-disposable sampling equipment, including the pump and support cable and electrical wires in contact with the sample, be decontaminated thoroughly each day before use ("daily decon").

EPA's field experience indicates that the life of centrifugal pumps may be extended by removing entrained grit. This also permits inspection and replacement of the cooling water in centrifugal pumps. All non-dedicated sampling equipment (pumps, tubing, etc.) must be

decontaminated after each well is sampled ("between-well decon," see #18 below).

17. **Daily Decon**

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5 minutes and flush other equipment with fresh detergent solution for 5 minutes. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

D) Disassemble pump.

E) Wash pump parts: Place the disassembled parts of the pump into a deep basin containing 8 to 10 gallons of non-phosphate detergent solution. Scrub all pump parts with a test tube brush.

F) Rinse pump parts with potable water.

G) Rinse the following pump parts with distilled/ deionized water: inlet screen, the shaft, the suction interconnector, the motor lead assembly, and the stator housing.

H) Place impeller assembly in a large glass beaker and rinse with 1% nitric acid (HNO_3).

I) Rinse impeller assembly with potable water.

J) Place impeller assembly in a large glass bleaker and rinse with isopropanol.

K) Rinse impeller assembly with distilled/deionized water.

18. **Between-Well Decon**

A) Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.
B) Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Alconox, for 5

minutes and flush other equipment with fresh detergent solution for 5 minutes. Use the detergent sparingly.

C) Rinse: Operate pump in a deep basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

D) Final Rinse: Operate pump in a deep basin of distilled/deionized water to pump out 1 to 2 gallons of this final rinse water.

VIII. FIELD LOG BOOK

A field log book must be kept each time ground water monitoring activities are conducted in the field. The field log book should document the following:

- Well identification number and physical condition.
- Well depth, and measurement technique.
- Static water level depth, date, time, and measurement technique.
- Presence and thickness of immiscible liquid layers and detection method.
- Collection method for immiscible liquid layers.
- Pumping rate, drawdown, indicator parameters values, and clock time, at three to five minute intervals; calculate or measure total volume pumped.
- Well sampling sequence and time of sample collection.
- Types of sample bottles used and sample identification numbers.
- Preservatives used.
- Parameters requested for analysis.
- Field observations of sampling event.
- Name of sample collector(s).
- Weather conditions.
- QA/QC data for field instruments.

IX. REFERENCES

Cohen, R.M. and J.W. Mercer, 1993, DNAPL Site Evaluation, C.K. Smoley Press, Boca Raton, Florida.

Puls, R.W. and M.J. Barcelona, 1996, Low-Flow (Minimal Drawdown) Groundwater Sampling Procedures, EPA/540/S-95/504.

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